U. S. DEPARTMENT OF COMMERCE

PUBLIC LIBRARY
AUG 3 1937
DETROIT

Technical News Bulletin

of the

National Bureau of Standards

★ *Issued Monthly* ★

Washington AUGUST 1937 Number 244

CONTENTS

Recent developments of the theory of turbulence.
Sudden disturbances of the ionosphere.
Protective screening of radium during transportation.
Industrial uses for silver.
Rapid photomicrography.
Water resistance of packaging materials.
Permeability of organic polysulphide resins to hydrogen.
Device for testing haemacytometer pipettes.
Temperature and hysteresis errors in calomel half-cells.
Crystalline talose acetates and orthoesters.
Infrared absorption of hydrocarbons.
Hydration of magnesia in dolomitic hydrated limes and putties.
Vibrograph for measuring the transmission of vibration through fresh concrete.
Square solder wire.
New and revised publications issued during July 1937.
Mimeographed material:
Letter circulars.
Technical Information on Building Materials.
Recent Bureau articles appearing in outside publications.

RECENT DEVELOPMENTS OF THE THEORY OF TURBULENCE

Since the days of Boussinesq and Reynolds, more than 60 years ago, the theory of the turbulent motion of a fluid has fascinated the minds of scientist and engineer alike. The engineer in his daily experience observed the irregular motion of water in eddying masses and some knowledge of the laws of this motion was a requisite to his professional success. The scientist found the problem a knotty one and some of the foremost intellects of the last half century have tackled it with indifferent success. Its challenge still stands, and its satisfactory solution still awaits that "happy idea" of which von Kármán once spoke, for even the most suitable fundamental concepts have not yet been crystallized.

Recently the attack has turned in a new direction under the leadership of G. I. Taylor, and some understanding of the nature of this new attack should be a possession of every engineer. It has seemed worth-while to attempt to survey the situation for those who are too busy with pressing practical engineering tasks to read the ever-increasing literature, which is often highly technical and adorned with much mathematical ornament.

The more recent developments have been stimulated by the intensive development of experimental methods for the study of turbulent flow, in particular for measuring certain statistical properties of the fluctuations of velocity with time. The theory appears to be laying hold of the fundamental phenomena and although it has not yet advanced to the point where it can replace the older empirical methods of attack, the outlook is favorable.

A review of the recent developments, containing a short summary of the basic concepts and a list of 31 papers and books has been prepared by Hugh L. Dryden, chief of the Bureau's Division of Mechanics and Sound, and submitted for publication in the Journal of Applied Mechanics, issued by the American Society of Mechanical Engineers.

SUDDEN DISTURBANCES OF THE IONOSPHERE

Radio transmission at high frequencies is subject to fading, interruption by magnetic storms, and many other vagaries. The most striking of these is an occasional complete disappearance

of signals for a brief period, say 15 minutes. This is called a fade-out. It was first recognized as a separate effect in 1935, when it was discovered to occur everywhere on the illuminated half of the globe but not on the night half. It was also discovered that, wherever it occurred, the effect was simultaneous.

This attracted great interest, and a world-wide investigation has since been in progress. It has been discovered that perturbations of the earth's magnetism and of earth currents sometimes occur at the same time as the radio fade-outs. These perturbations are of very different type from the effects occurring during magnetic storms. They are, for instance, small near the poles and great at the Equator, just the opposite of magnetic storm effects.

Both the radio and the magnetic effects are at their greatest in that region of the earth where the sun's radiation is perpendicular. They are, for instance, more pronounced where the time is noon than in places where it is some other time of day. A radio fade-out which is observed at a certain place in the morning is most severe and complete for transmissions from the east, and when observed in the afternoon is most severe for transmissions from the west.

The effect is "public enemy number one" of radio. The disappearance of signals is so complete, in the major fade-outs, that the listener often wonders whether the power has become disconnected or a wire broken. Many an anxious radio operator has dissected his receiving set during a fade-out to try to find out why it went dead. The effect is not as pronounced at broadcast frequencies as at higher frequencies.

A study of the ionosphere, the ionized upper atmosphere, under the direction of J. H. Dellinger, chief of the Bureau's radio section, has indicated that a fade-out is due to a very sudden increase of ionization of a certain region of the ionosphere lying below the recognized layers which reflect radio waves and make long-distance high-frequency transmission possible. Knowledge of the behavior of this region helps to explain some of the facts of radio transmission and is also leading the way to a determination of the causes of fluctuation of the earth's magnetism.

There have been 118 of these fade-outs in the past 2 years, and in 59 of them an eruption was observed on the sun at the same time as the fade-out. The eruption on the sun sends out a great burst of ultraviolet light, which causes the sudden increase of ionization in the ionosphere, which in turn causes the radio fade-out and the magnetic and earth-current effects. This is leading to increased knowledge of the nature of sunspots and other phenomena of the sun.

Radio fade-outs have thus been demonstrated to be a species of radio interference caused by radiations from 93,000,000 miles away. This effect, while a serious enemy of radio, is proving to be a very good friend of science in studies of the nature of the ionosphere, the processes of radio-wave transmission, the mechanisms of terrestrial magnetism, and the phenomena occurring in the sun.

An interesting report of this investigation will be published as RP1016 in the August number of the Journal of Research.

PROTECTIVE SCREENING OF RADIUM DURING TRANSPORTATION

The problem of screening medical radium preparations during transportation has received renewed attention since the recent order of the United States Post Office Department excluding all radioactive preparations from the mails. This exclusion was not ordered to protect personnel, but to protect photographic film, large quantities of which are shipped by mail.

This action caused considerable protest on the part of users of radium and radon, and the Post Office Department requested the Bureau to investigate conditions under which radium might be transported with safety to photographic films. In the course of this investigation which was conducted by L. F. Curtiss, it became obvious that the protection of film imposes much greater restrictions than the protection of personnel, so that the satisfactory solution of the film problem would also result in regulations which would eliminate any chance of personal injury from radium while in transit.

Preliminary exposures of ultra-speed X-ray film to preparations of various radium content through different lead filters at distances ranging from a few inches to several feet clearly revealed that for radium preparations containing 25 to 100 mg of radium no reasonable amount of lead screening alone would protect photographic film, for the length of time they might be together in a mail pouch. As in many other instances, it became evident that the inverse square law must be utilized by restricting the minimum distance between the radium package and the photographic film. Further studies revealed that this minimum distance must

be from about 4 to 20 feet, depending on length of exposure, thickness of lead filter, and strength of radium preparation. Obviously, it would be impossible to use a package so arranged that it would be safe to store photographic film in contact with it.

From these orienting tests it seemed best to first design a package giving reasonable protection to persons handling it, making the package as compact as possible, consistent with such protection. Secondly, figures were secured to show the thickness of lead filter required for different distances, exposure times, and radium content up to 100 mg. These results were plotted, and from the curves thus obtained a table has been prepared for the use of shippers and transportation companies to indicate the amount of lead screening and the minimum safe distance from photographic film, for a given amount of radium for a particular time in transit.

The package used in obtaining these data was designed to insure a thoroughly safe distance between the hand and the radium container. It is about 14 inches in length and 6 inches square, and is arranged to stand conveniently with its long dimension upright. A rigid handle is attached to the upper end. The compartment for the lead cell containing the radium is located centrally near the bottom so that the hand is about 10 inches from the radium. Even if the hand should be placed against the side of the box opposite the radium container it would be nearly 3 inches from it. There is no reason why this should be necessary, and the aim in designing the package has been to make it inconvenient to carry it in any other way than by the handle. Thus, the use of this package in combination with the table of safe distances should make possible the transportation of radium without danger to personnel and goods in transit.

INDUSTRIAL USES FOR SILVER

Previous issues of the Technical News Bulletin have contained references to the investigation by the Bureau and a number of the leading silver producers on the problem of developing new industrial uses for silver. This culminated in the publication of Circular C412, "Silver: Its Properties and Industrial Uses" in October of last year. See Technical News Bulletin 236, page 113 (December 1936).

Since that time a new project has been started, officially designated as the American Silver Producers' Research Project, having the same general objective as the first investigation, but designed to attack the problem on a much broader front. Fifteen research fellows have been located in 9 different institutions, including the Bureau, and are working on various phases of the problem. At the present time preliminary arrangements have been completed, all the fellowships awarded, funds allocated, and the main outlines of the approach decided upon.

As the result of interviews with those in charge of various research organizations many different viewpoints have been considered. It has been decided to follow up each suggestion thus obtained, as well as those offered by members of the technical advisory committee representing the sponsors, insofar as practicable. As the result of careful consideration, a schedule has been decided upon in which each phase of the work has been located at an institution where research of that general character is already under way. The schedule includes studies of argyria, bactericidal properties, chemical properties, fungicidal properties, physico-chemical properties, electroplating, electrical characteristics, thermal properties, and metallurgical possibilities.

The whole project will be coordinated from the National Bureau of Standards. Since the metallurgical field at present appears the most promising for new uses capable of absorbing a considerable part of the annual silver production, 7 of the 15 men chosen as research fellows have been assigned metallurgical problems. Three of these seven have been assigned to the Bureau's Division of Metallurgy, headed by H. S. Rawdon. The senior research associate, A. J. Dornblatt, formerly head of the metallurgy and chemistry section of the United States Naval Academy Post Graduate School, will act as the coordinating officer for the entire project so that duplication of work among the different laboratories will be avoided. A considerable portion of his time will be spent contacting industry in order that commercial concerns may be interested in the work being done and to insure that the project does not duplicate work being carried on in industrial laboratories. Mr. Dornblatt will be assisted by A. M. Setapen, research associate, formerly teaching assistant in the Graduate School of the Carnegie Institute of Technology, and by T. W. Allen, research assistant.

Some problems being investigated include the effect of silver additions on the common engineering alloys, development of mechanically superior high-

silver alloys, characteristics of silver commutators, effects of silver in bearing metals, piston ring inserts of silver or silver alloy, silver soldering irons, characteristics of welding rod containing silver, catalytic properties of silver, heat-transfer data on silver and its alloys, optical reflectivity of silver alloys, effect of silver on spore germination, intravenous injection of silver compounds, and electrodeposition of silver alloys.

It is the intention to publish progress reports from time to time in the Technical News Bulletin. It is also desired and planned to cooperate with industry in following up suggestions regarding possible new industrial applications of silver.

RAPID PHOTOMICROGRAPHY

An apparatus has been constructed by Willard Mutchler and Henry O. Willier of the Bureau's Metallurgical Division, by means of which it is possible to make photomicrographs rapidly. The apparatus, which is now in use at the Bureau, employs roll film or paper, thus dispensing with the repeated loading and unloading of individual film holders. Some 900 negatives, each 4 by 5 inches, are secured from a single loading when paper is used. Provision is made for autographing identification symbols on the exposed paper.

A split-beam prism and an auxiliary focusing eyepiece make it unnecessary to remove the holder for purposes of focusing.

The apparatus is being utilized at present to obtain permanent records of the structural effect of corrosion on cross sections of metallic specimens, approximately 700 micrographs being made per working day. The photomicrographs are taken directly on this bromide-emulsion paper of the usual photostat grades. For many purposes the image on the paper negatives reveals sufficient detail to obviate the need for making prints. Satisfactory prints, however, can also be made from the paper negatives.

WATER RESISTANCE OF PACKAGING MATERIALS

Moisture-resistant wrappings for bread, cake, potato chips, candy, cereals, tobacco, and a great variety of articles of commerce that are affected by moisture in the atmosphere have become so familiar as to be regarded as a matter of course. Rubber and other materials used to protect electrical conductors laid under water, paint and varnish films to protect wood and metal surfaces, aircraft finishes, and gas-cell fabrics in airships are other examples of films and membranes that must be highly resistant to moisture. The effectiveness of these membranes in resisting moisture is the direct result of intense scientific and technical development. One of the most important tools in such development is an adequate method of testing permeability to water vapor.

A survey of the published data on the measurement of the permeability of membranes to water vapor indicates the considerable variety of methods and procedures used and the manner in which recognized variables affect the tests. The study emphasizes the need for correlation of data and standardization of testing methods. Four types of methods, comprising many minor modifications, have been employed. The test period ranged from 2 to 2,000 hours; the temperature from $-14°$ to $45°$ C; the vapor-pressure difference from 0 to 72 mm of mercury; the area of the specimen from 0.15 to 323 cm^2. Considerable individuality has also been exercised in the method of attaching the specimen to prevent leakage, the movement of air in contact with the specimen, the approach to the steady state, and the units of expressing the results. The data have been reported in at least 20 different units.

The data from many sources indicate that the permeability to water vapor of materials commonly used in wrapping and packaging hygroscopic substances ranges all the way from that of waxes, rubber, and varnish films, on the one hand, to that of leather and textiles on the other. The permeability of membranes to air and other gases is no indication of the permeability to water vapor. Rubber, for example, is about 50 times more permeable to water vapor than to hydrogen, and some of the common transparent wrapping materials may be a thousand times more permeable to water vapor than to air.

The data indicate that the amount of moisture that will pass through a membrane is proportional to the area, the time in the steady-state range, and the vapor pressure difference within certain limits. Some report it inversely proportional to the thickness, while others disagree. A seal to prevent leakage at the edges is considered of the utmost importance. The relative humidity, especially at high values, has a marked influence. The temperature requires close control.

Several mechanisms whereby water vapor is able to pass through many membranes that are almost impervious

to air have been suggested. Diffusion in the manner of other gases probably plays a minor role. Some believe that the moisture dissolves in the membrane and diffuses in solid solution through it. Others associate the moisture transpiration with the content of hygroscopic moisture, believing the two proportional. Still others attempt to explain moisture transpiration in terms of absorption phenomena, believing that the moisture is absorbed and migrates along internal surfaces provided by the regions of separation between crystallites.

PERMEABILITY OF ORGANIC POLYSULPHIDE RESINS TO HYDROGEN

Because of its extraordinary stretching properties, rubber has long been used as a gas-retaining material. Since the day in 1783 when Charles and the Robert brothers released in Paris a small balloon constructed of taffeta coated with rubber, this material has been the most widely used to construct lighter-than-air craft. Rubber is not, however, an inherently impermeable material, as shown by the slow leakage of air from an inner tube of an automobile tire. This leakage, however, is of little importance compared to the losses which can occur in various types of balloons, gas envelops, ballonets, and gas cells. Here are encountered the combination of several thousand square yards of fabric, coated with films which may be five- or six-thousandths of an inch thick, required to contain hydrogen or helium, both of which gases permeate rubber more rapidly than does air. The escape of lifting gas and, at the same time, the dilution of the gas within the structure by air leaking in, are of greater consequence in large airships of the rigid type than they are with small ships or balloons. Modern ships of the Zeppelin type have a gas volume of over 6,500,000 cubic feet.

The property of elastic extensibility is not confined to rubber alone. One direction of expansion of the plastics industry has been the development of materials which bear little or no relation chemically to rubber but possess a rubberlike elasticity at normal temperatures. The organic polysulphide resins belong to this class of substances. They are more familiarly known under the registered trade-mark Thiokol. They differ from rubber in that they show marked resistance to gasoline and oils, which readily swell and weaken the structure of rubber. That a relation may exist between solvent resistance and permeability to gases is indicated, not only by the behavior of the organic polysulphide resins, but also by that of compounds containing polychloroprene, which as Neoprene is well known as a rubberlike plastic possessing resistance to solvents. The permeability to hydrogen of this material is much less than that of rubber.

The comparative behavior of rubber and the organic polysulphide resins, respectively, can be shown by a concrete example. The permeability of a film is customarily expressed in terms of volume, area, and time. A closely woven cotton fabric coated with an organic polysulphide resin to the amount of 3 ounces per square yard will allow hydrogen to permeate at the rate of about 0.01 cubic foot per square yard in 24 hours. A fabric having the same weight of coating of rubber will have a permeability of nearly 70 times that of the synthetic material.

Aside from the facts that balloon fabrics coated with organic polysulphide resins possess the characteristic of rubberlike flexibility and have a low permeability to lifting gases, they present a distinct advantage over fabrics coated with hydrophilic colloids, such as gold-beaters skin and gelatine, highly hygroscopic substances, in that they are not subject to great variations in weight with changes in atmospheric humidity.

The reason for the low permeability of these resins can be surmised only in a general way. Possible explanations are contained in a paper by Theron P. Sager in the August Journal of Research (RP1020). In these substances the sulphur atoms are enormously large compared to the other constituents of the molecule. Assuming that they possess a chain structure, they are in effect linear polymers of sulphur atoms. If the passage of gas through the material is simply filtration through intermolecular spacings the low permeability of these resins might be attributed to a high structural density. If the process consists of absorption of the gas on the surface of the material followed by diffusion through it, one would expect that substances containing such large amounts of sulphur would be inert compared to a material such as rubber and hence would offer much less solvent action toward hydrogen.

DEVICE FOR TESTING HAEMACYTOMETER PIPETTES

An instrument for the rapid and accurate testing of haemacytometer and other pipettes of small capacity employing a volumetric method, has been designed and constructed by Elmer L.

Peffer, chief of the Bureau's Capacity and Density section. The increased demand for pipettes which have been tested by the Bureau made the development of this device necessary.

The instrument consists of a small horizontal glass cylinder with double walls. The space between the walls is evacuated to reduce temperature effects, and the inner cylinder is filled with a colored noncorrosive solution. Into the two ends of the cylinder project small steel plungers which may be forced into or withdrawn from the cylinder by turning micrometer screws. These plungers are lapped to size and the cross-sectional area of one is 10 times that of the other. A dome on the upper portion of the cylinder has an opening with a rubber stopper into which the top of the pipette is inserted.

In making a test the liquid is driven up the tube of the inverted pipette by the large plunger to the first division, and a reading is then taken on the micrometer. The liquid is then driven through the bulb to the first ruling on the stem, and a second reading is taken. The small plunger is then used to drive the liquid up the stem, readings being taken at the required points. The volume of liquid displaced by the large plunger being 10 times that displaced by the small one, the number of turns, and hence the readings of the two micrometers, will be equal if the ratio of bulb to stem of the pipette is 10 to 1.

The micrometer heads used were taken from the ordinary type of depth micrometers and the plunger assembly sealed into the glass cylinder with Kotinsky's cement.

A complete description of the instrument will be published as RP1019 in the August number of the Journal of Research.

TEMPERATURE AND HYSTERESIS ERRORS IN CALOMEL HALF-CELLS

In the calculation of pH or hydrogen ion concentrations of solutions from electromotive force measurements, temperature is an important factor. The potentials of both halves of a measuring cell, at constant pH, change at uniform rates over the usual room temperature range in which measurements are made. This uniform rate of change, called the $\Delta A/\Delta T$ of the half-cell, is usually different for each one. While the temperature is changing, a lag or hysteresis occurs in the potential of the half-cell, which causes the measured emf of the combination of half-cells to be temporarily different from the equilibrium value corresponding to the temperature.

Some experiments have been performed by Baker Wingfield and S. F. Acree on the calomel half-cell, which is commonly used in conjunction with the glass, hydrogen or quin-hydrone half-cells for pH measurements, to determine the amount of error which this half-cell could introduce in the results.

The calomel half-cell consists of a layer of pure mercury covering a platinum contact wire. Above the mercury and in contact with it is a solution of potassium chloride saturated with and containing an excess of mercurous chloride. The potential of the half-cell depends upon the concentration of the mercurous ion which can be varied by changing the temperature and also by changing the concentration of potassium chloride. Three types of calomel half-cells were placed in an air bath, the temperature of which could be regulated. One type contained an excess of potassium chloride to keep the solution saturated in the range of temperature used; one was filled with a solution saturated at 25° C and was consequently undersaturated at higher temperatures, but at lower temperatures it was either supersaturated or reduced in concentration by crystallization; and one was filled with a solution undersaturated at all temperatures used. These half-cells were connected through glass tubes filled with the same potassium chloride solution to saturated calomel half-cells located outside of the air bath and kept constant at 25.0° C. The air bath temperature was changed up and down between 22.5 and 31.3° C and the e. m. f.-time relationship noted. At various points, the temperature was regulated to a constant value until the half-cells reached equilibrium with respect to both temperature and potential.

The data, which are reported in the Journal of Research for August (RP1018), indicated that, except for the half-cell saturated at 23° C without an excess of KCl crystals, the hysteresis of the half-cells amounted to 0.5 to 0.9 mv, which was equivalent to 0.01 to 0.02 pH. If no corrections are made for the $\Delta E/\Delta T$ of the half-cells, errors of 0.04 to 0.07 pH unit occur for an 8° C temperature change. When the room temperature fluctuated only 1 or 2° C above or below some mean temperature, the temperature variation of the half-cell can be reduced, by insulating it in a dewar flask, to such an extent that the half-cell potential change is equivalent to less than 0.01 pH unit.

Some general conclusions are, that for rough measurements to 0.1 pH, no corrections need be applied for temperature variations of 8° C; that for precise measurements to 0.01 pH the reference and hydrogen ion half-cells should be kept at constant temperature for several hours before the measurements are made; and that the saturated calomel half-cell with an excess of solid potassium chloride is more serviceable for general use than other types of half-cells as its $\Delta E/\Delta T$ is small and evaporation will not change its potential.

CRYSTALLINE TALOSE ACETATES AND ORTHOESTERS

Sixteen types of aldohexose structures are theoretically possible when only one ring structure and one of the two possible enantiomorphs are considered. The preparation of *β-d* talose, which is reported in RP1021 by William Ward Pigman and Horace S. Isbell in the August number of the Journal of Research, is the tenth type to be obtained. These various isomers differ only in the spatial arrangements of the hydrogen atoms and hydroxyl groups about the basic pyranose ring. Hence, the preparation of this new sugar is of importance since it extends our knowledge of the effect of optically active groups upon one another. Thus, it is shown that Hudson's *2A* value for *d*-talose, which is supposedly twice the rotation of the reducing carbon (carbon 1) with its attached groups, is close to that of *d*-mannose, which has a similar arrangement of groups about carbon atoms 2 and 3. In reactions involving carbons 2 and 3, derivatives of talose resemble those of mannose. Thus, both 1-bromo-tetra-acetyl talose (which is reported for the first time) and the corresponding mannose derivative react with silver carbonate and methyl alcohol to give sugar ortho-methylacetates which have a secondary 5-membered ring. This behavior is in contradistinction to that of the other known halogeno-acetyl hexoses which form acetylated glycosides under similar conditions. Apparently the repulsive influence of atoms attached to carbon 3 on those attached to carbon 2, which in talose are close together, is responsible for these effects. On the other hand, for reactions involving groups attached to other atoms, talose may resemble other sugars. This is particularly true of the mutarotation reaction since both forms of *d*-talose resemble the corresponding *α-* and *β-d*-galactose in deviating, in a similar but much more pronounced fashion, from the course of a simple first-order reaction.

Several important derivatives of *d*-talose are reported for the first time. The *α*-penta-acetyltalose crystallizes very readily and may be used for the purification and the identification of substances suspected as talose. The 1-bromo-tetra-acetyl talose is an important intermediate for the preparation of derivatives of *d*-talose. The preparation of one of these derivatives, *α*-tetra-acetyl talose, is described.

The separation of a new crystalline monobenzol talose from the products obtained by the oxidation of galactal with perbenzoic acid accounts for hitherto unknown impurities in sugars prepared by the glycol method. In addition, the new substance, which probably is a talose 1, 2-orthobenzoic acid, throws light on the mechanism of the oxidation reaction and upon the reactions to be expected of such structures.

INFRARED ABSORPTION OF HYDROCARBONS

In the investigation on the composition of petroleum, conducted at the Bureau in cooperation with the American Petroleum Institute, various methods have been developed to assist in the identification of the hydrocarbons isolated from the crude petroleum. A relation between the constitution of hydrocarbons and their absorption spectra in the near infrared was demonstrated in a cooperative project with the Fertilizer Investigation Laboratory, Bureau of Chemistry and Soils, Department of Agriculture. The shape of the infrared absorption curve, with particular reference to the occurrence of maxima, is determined by the presence of characteristic groups in the molecule (such as phenyl, methyl, etc.). The scope of the work has now been enlarged, and a report by Frank W. Rose, Jr., on 9 hydrocarbons of low molecular weight (lying in the "gasoline" region) and 10 of high molecular weight (lying in the "lubricating-oil" region) will be published as RP1017 in the August number of the Journal of Research. The data cover the region 5,400 to 8,900 cm^{-1} (1.82 to 1.12) and were calculated in the form of plots of the molal absorptive index against the wave number.

HYDRATION OF MAGNESIA IN DOLOMITIC HYDRATED LIMES AND PUTTIES

The term "dolomitic lime" is applied to those limes made up of calcium and magnesium oxides in nearly equimolecular proportions. Large quantities of such

limes are produced commercially in a hydrated form for use in plastering and in masonry mortar.

Although the calcium oxide in these so-called hydrated dolomitic limes is almost completely hydrated, the magnesia is largely unhydrated owing to the slowness with which it combines with water, especially when burned at temperatures used in the lime industry. In fact, the conditions necessary for the hydration of magnesia in these limes, the rates of hydration, and practical methods of measuring these are not well known. They are, however, important factors in the consideration of the durability of plaster and masonry construction, because the hydration of magnesia is attended by marked expansion. Should appreciable hydration take place after the plaster or mortar has "set", damaging expansion may result.

In a recent investigation by Lansing S. Wells and Kenneth Taylor, reported in the Journal of Research for August (RP1022), a heat-of-solution method was developed for measuring the degree of hydration of magnesia in dolomitic hydrated limes, and in particular, in dolomitic hydrated lime putties. The method is based upon the fact that as a lime hydrates, its heat of solution diminishes. In this method, it is necessary to know the chemical analysis of a lime and its heat of solution at the start and after complete hydration. (Such limes may be completely hydrated by subjecting them to steam under pressure). The hydration of magnesia under various conditions can then be followed by making additional heat-of-solution determinations from time to time. Using the heat of solution method as a basis of comparison, it was found that a simple and quick method for ignition loss could satisfactorily be used for measuring the amount of magnesia hydrated.

By means of such methods, the rate of hydration of magnesia in six commercial hydrated limes, under various conditions, was studied. In these hydrates, it was found that from 3 to 23 percent of the magnesia was hydrated when purchased, and that the customary 1 day of soaking hydrated only 5 to 8 percent additional. On an average, about 3 months of soaking at room temperature was required to hydrate 95 percent of the magnesia. However, the rate of hydration was much more rapid at higher temperatures. Thus, in a lime representative of the group, 95 percent of the magnesia hydrated in 35 hours when the temperature of the putty was maintained at 85° C. When this lime was exposed to steam at 177° C. (120 lb./in.^{2} pressure), 95 percent of the magnesia hydrated in 40 minutes.

Exposure of these limes to moist air was found to hydrate the magnesia slowly. Thus, exposure for 3 to 4 months in a relative humidity of approximately 50 percent was equivalent to 1 day of soaking. At lower relative humidities, the indications are that the rates of hydration would be extremely slow.

VIBROGRAPH FOR MEASURING THE TRANSMISSION OF VIBRATION THROUGH FRESH CONCRETE

During the course of studies of the compaction of fresh concrete by vibration it was thought desirable to develop an apparatus for measuring the amplitudes and frequencies of the vibrations within the concrete. An electromagnetic pick-up unit and amplifying unit for use in conjunction with a cathode ray oscillograph have been designed by George L. Pigman, assisted by J. S. Rogers and F. B. Hornibrook, and built at the Bureau for this purpose.

The pick-up unit, inclosed in a rigid, watertight case, consists essentially of an electromagnet suspended from the case by two springs having a low natural period, and a pick-up coil, rigidly attached to the case, which moves in the air-gap of the magnet. The case (outside dimensions of which are approximately 2¼ by 2½ by 2¼ inches) is attached by means of a semiflexible joint to a metal tube several feet long, through which the lead wires extend. By this arrangement the unit can be used as a probe to pick up the vibration at different positions in a mass of concrete being vibrated. The unit is designed to respond only to vibrational motion in the horizontal direction.

The signal from the pick-up unit (which is a measure of its velocity of vibration) passes through an electrical integrating unit of the resistance-capacitance type and the signal thus integrated is a measure of the amplitude of vibration. From the integrating unit the signal passes through a 3-stage amplifying unit to the oscillograph. A volume control incorporated in the amplifier allows various amplitude ranges to be chosen in such a manner that any amplitude from 0.04 of an inch to 0.00001 of an inch can be made to yield an oscillograph deflection that will extend over at least one-third of the oscillograph scale. Accordingly, measurements of a steady signal can be made over that range of amplitudes within an accuracy of about 3 percent.

Calibration of the pick-up unit was made by measuring optically the amplitude of the unit placed on a plate made to vibrate near its natural frequency by a rotating eccentric weight. The amplitude ranges below 0.0003 of an inch were not calibrated directly, but were evaluated by means of an electrical calibrating device. This device consists of a voltage divider, operated with alternating current, which gives known output voltages corresponding to actual amplitudes. The evaluation of the amplitude ranges below 0.0003 of an inch was then obtained by extrapolation from the values obtained for the measured amplitude ranges.

The measured value on the vibrograph of a constant amplitude shows a variation of less than 3 percent for frequencies ranging from 30 cycles to over 300 cycles per second. This frequency range well covers that of commercial vibrators.

Studies are now being made in the laboratory by F. B. Hornibrook and George L. Pigman of the vibration of concrete with commercial vibrators.

SQUARE SOLDER WIRE

Solder wire of less than the usual diameter of ⅛ inch has important advantages, particularly for those who solder with a blowtorch or with a jeweler's blowpipe. By having the wire in a number of sizes, it is easy to cut off just the right amount of solder for putting two small parts together; while if many pieces are needed, they can be made of practically the same size, if this is desirable. An additional improvement, which seems to have originated with a former mechanician of the Bureau, is to make the wire square, instead of round. If it is of this shape, the small pieces cut off do not roll out of place when the flame hits them. Round wire can be flattened slightly by hammering, but is not as convenient to use as the square wire.

NEW AND REVISED PUBLICATIONS ISSUED DURING JULY 1937

Journal of Research[1]

Journal of Research of the National Bureau of Standards, volume 19, number 1, July 1937 (RP1006 to RP1015, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers[1]

[Reprints from the May 1937 number of the Journal of Research]

RP998. State of the sulfur in oxidized wool. Milton Harris and Arthur L. Smith. Price, 5 cents.

Simplified Practice Recommendations[1]

R159–37. Forged hammers. (Supersedes R159–35.) Price, 5 cents.
R160–37. Forged hatchets. (Supersedes R160–35.) Price, 5 cents.
R166–37. Color code for marking steel bars. Price, 5 cents.
R168–37. Braided shoe laces. Price, 5 cents.

Technical News Bulletin[1]

Technical News Bulletin 243, July 1937. Price, 5 cents. Obtainable by subscription.

MIMEOGRAPHED MATERIAL

Letter Circulars

Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or to send copies automatically as issued.

LC501. A guide to the literature on rubber.

Technical Information on Building Materials

The supply of these notes, each of which consists of three or four pages giving the important facts on some one aspect of the properties or use of building materials, is necessarily limited. Their distribution will be confined to Government officials concerned with building projects, and to architects, engineers, and home builders. Requests should make clear the actual need for the information at the time of writing. Letters should be addressed to the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C. The following notes have been issued since the list published in the June 1937 number of the Technical News Bulletin:

TIBM–49. Wood and shingle stains.
TIBM–50. Corrosion of nonferrous metals under ground.

[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $2.50 per year (United States and its possessions, and Canada, Cuba, Mexico, Newfoundland, and the Republic of Panama); other countries, 70 cents and $3.25, respectively.

RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS[2]

Simplified equipment for determining cloud height and thickness. H. Diamond. Bul. Am. Meteorological Soc. (Blue Hill Observatory, Milton, Mass.) **18**, 99 (April–May 1937).

Skip distance calculation. N. Smith. QST (38 La Salle Road, West Hartford, Conn.) **21**, 47 (May 1937)

The ionosphere and magnetic storms. S. S. Kirby, T. R. Gilliland, N. Smith, and S. E. Reymer. Phys. Rev. (Am. Inst. Physics, New York, N. Y.) **51**, 992 (June 1, 1937).

Flow nozzle research. Howard S. Bean. Instruments (1117 Wolfendale St., Pittsburgh, Pa.) **10**, 156 (June 1937).

Determining flow nozzle contours at Bureau of Standards. Francis C. Morey. Instruments **10**, 157 (June 1937).

Research on flow nozzles. Howard S. Bean. Mech. Eng. (29 West 39th St., New York, N. Y.) **59**. 500 (July 1937).

Progress reports nos. 3, 4, 5 on stress distribution in steel rigid frames. Staff of Engineering Mechanics Section. (Am. Inst. Steel Construction, 200 Madison Ave., New York, N. Y.) (June 29, July 18, and July 31, 1936).

Heat-treated bridge wire. W. H. Swanger and G. F. Wohlgemuth. Engineering (London) **148**, 725 (June 25, 1937).

Diffusion in solid metals. A. I. Krynitsky. Metals and Alloys (1117 Wolfendale St., Pittsburgh, Pa.) **8**, 173 (June 1937).

Method for approximating the glass content of Portland cement clinker. Wm. Lerch and L. T. Brownmiller. Paper no. 32, Portland Cement Assn. Fellowship (Dr. R. H. Bogue, National Bureau of Standards, Washington, D. C.) (May 1937).

The wick test for efflorescence of building brick. John W. McBurney and Douglas E. Parsons. Preprint no. 58, Am. Soc. Testing Materials (260 South Broad St., Philadelphia, Pa.) (June 1937).

[2] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

U. S. GOVERNMENT PRINTING OFFICE: 1937